



US006466908B1

(12) **United States Patent**
Baggenstoss

(10) **Patent No.:** **US 6,466,908 B1**
(45) **Date of Patent:** **Oct. 15, 2002**

(54) **SYSTEM AND METHOD FOR TRAINING A CLASS-SPECIFIC HIDDEN MARKOV MODEL USING A MODIFIED BAUM-WELCH ALGORITHM**

6,055,498 A • 4/2000 Neumeyer et al. 434/185
6,112,021 A • 8/2000 Brand 382/224
6,226,611 B1 • 5/2001 Neumeyer et al. 434/185

OTHER PUBLICATIONS

(75) **Inventor:** Paul M. Baggenstoss, Newport, RI (US)

IEEE Signal Processing Letters, vol.: 4. Iyer et al., "Using out-of-domain data to improve in-domain language models" pp. 221-223 vol.: 4 Issue: 8, Aug. 1997.*

(73) **Assignee:** The United States of America as represented by the Secretary of the Navy, Washington, DC (US)

* cited by examiner

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

Primary Examiner—Richemond Dorvil
(74) *Attorney, Agent, or Firm*—Michael J. McGowan; James M. Kasischke; Michael F. Oglo

(57) ABSTRACT

(21) **Appl. No.:** 09/484,132

A system and method for training a class-specific hidden Markov model (HMM) is used for modeling physical phenomena, such as speech, characterized by a finite number of states. The method receives training data and estimates parameters of the class-specific HMM from the training data using a modified Baum-Welch algorithm, which uses likelihood ratios with respect to a common state (e.g., noise) and based on sufficient statistics for each state. The parameters are stored for use in processing signals representing the physical phenomena, for example, in speech processing applications. The modified Baum-Welch algorithm is an iterative algorithm including class-specific forward and backward procedures and HMM reestimation formulas.

(22) **Filed:** Jan. 14, 2000

(51) **Int. Cl.⁷** G10L 15/14

(52) **U.S. Cl.** 704/256; 704/240

(58) **Field of Search** 704/256, 255, 704/251, 240, 239, 200, 231, 232

(56) References Cited

U.S. PATENT DOCUMENTS

4,817,156 A • 3/1989 Bahl et al. 704/244
5,864,810 A • 1/1999 Digalakis et al. 704/254
5,963,906 A • 10/1999 Turin 704/232

11 Claims, 5 Drawing Sheets

